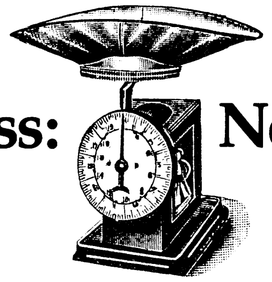
# SCIENCE NEWS OF THE WEEK

## From Russia With Mass: Neutrinos



Neutrinos have always been a highly elusive part of physics. The existence of this variety of subatomic particle was postulated about the year 1930, but it was not demonstrated by experiment until 1956. In 1980 neutrinos are still elusive, but extremely interesting, to judge by the concentration exhibited by the 60-odd particle physicists, nuclear physicists and cosmologists who gathered for the Miniconference and Workshop on Neutrinos with Mass held at Cable, Wis., last week.

The first postulations of the properties of neutrinos gave them a rest mass of zero. That means that they do not exist at rest. If they ever should come to rest, they would vanish. They would exist only in motion, that is. Of all the particles known to physics only neutrinos and photons (the particles of light) were thought to have this zero-rest-mass peculiarity.

Now the question is whether neutrinos do in fact have rest mass after all. As the Miniconference showed, there is experimental evidence of a nature that cannot be easily talked away, which shows that neutrinos have rest mass. If the evidence holds up, basic ideas in particle physics, nuclear physics and cosmology will be affected.

The most direct piece of evidence for neutrino rest mass comes from experiments that study the form of radioactivity known as beta decay of nuclei. It was for the accommodation of this process that the existence of neutrinos was originally postulated. Momentum and energy seemed to be disappearing. The neutrino was invented, an almost undiscoverable particle with a zero rest mass that enabled it to carry off any amount of energy from almost zero on up. Now beta decay is being used to search for a neutrino rest mass, which, although very tiny and therefore undiscoverable with the accuracy limits of older beta-decay experiments, nevertheless may exist.

The experiment that offers the most definite measurement has been operating for several years in Russia at the Institute for Theoretical and Experimental Physics at Novosibirsk. It records the spectrum of electrons given off by the beta decay of tritium bound in molecules of the amino acid valine ($C_5H_{11}NO_2$). In the experiment, two of the hydrogen atoms in the valine are replaced by tritium atoms. (Tritium is the isotope hydrogen-3.) From time to time, a neutron in a tritium nucleus turns itself into a proton, emitting an electron (in olden days called a beta ray) and an antineutrino. The experimenters use detecting equipment to record the electrons' energy and momentum. With this information the researchers try to calculate a probable rest mass for the antineutrino.

The general conclusion of the Novosibirsk experimenters, related to the Miniconference by Oleg Egorov, who represented them, is that "there is an indication that the electron antineutrino has a nonzero mass." (Whatever mass the antineutrino has, the corresponding neutrino will have.) Egorov gives the latest numbers. They are conditional on whether the energy-level structure of the helium-3 atom that is left in the valine molecule after the tritium atom decays affects the outcome of the antineutrino mass calculation. The antineutrino mass lies between 26 and 46 electron-volts if the energy-level structure of helium-3 affects the calculation or between 14 and 46 electron-volts if it does not.

Embedding the tritium in a silicon matrix is the method chosen for an experiment that has been running at the University of Guelph, Ontario, Canada. John Simpson of Guelph reported that the tritium is accelerated (in ionized form) in a Van de Graaff machine. It is then driven into a small block of silicon mounted in a notch in a piece of lithium. As Simpson puts it, "It buries itself inside this $10^{-6}$ ton detector." (A witticism at the expense of particle physicists, whose detectors usually go in the multiton range.) The tritium gets caught in the crystal matrix of the silicon, and the lithium is used to observe the electrons that come off in the beta decays. Simpson reports only very preliminary results for the moment, but he hopes to have completed the technical adjustments in about a year so as to be able to test with relatively high accuracy for a figure of 35 electron-volts. His study of the Russian experiment convinces him that that is really their best figure.

It would be good to be able to use gaseous atomic tritium. As Tom Bowles of Los Alamos Scientific Laboratory puts it, there are concerns about the Russian experiment: the effect of the molecule on the decay reaction and the possibility that the electrons were scattered before they left the solid source. "There are a lot of questions on the Russian experiment, but we haven't found anything definitely wrong," Bowles says. That inspired a group led by R. G. H. Robertson of Michigan State University to propose an experiment to the LASL administration that would use a beam of atomic tritium. The technology of this is very difficult, but Bowles mentions a device known as an ion trap, in which such a beam might be confined. It will take a year to get the kind of tritium beam they want, says Bowles, and probably two or three years for a statement of results.

It may take longer than that to come to some definite answer to the basic question. There are indirect ways of looking for neutrino mass, especially the search for evidence of so-called neutrino oscillations (SN: 5/10/80, p. 292; 6/14/80, p. 377). These plans and other things discussed at the symposium, especially some of the effects of the existence of neutrino mass, will be the subject of future articles. □

## Smoky and leukemia: High rate confirmed

Dept. of Energy

*Brush blazes beneath Smoky's rising cloud.*

A nearly threefold increase over the expected incidence rate for leukemia has been confirmed among participants in military maneuvers involving the 1957 nuclear-weapons test known as Smoky (SN: 2/11/78, p. 92). "If not a chance occurrence, the apparent excess of leukemia among Smoky participants suggests that such persons may have received more radiation than previously supposed or that low doses of radiation may be more carcinogenic than past estimates predicted," according to Glyn Caldwell and colleagues at the Center for Disease Control in Atlanta, Ga. An account of their study appears in the Oct. 3 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION.

Military records show that throughout the 1950s, an estimated 250,000 troops witnessed at relatively close range one or more nuclear-weapons blasts and practiced maneuvers afterward in regions where residual contamination may have